

***Eptatretus lakeside* sp. nov., a New Species of Five-Gilled Hagfish
(Myxinidae) from the Galápagos Islands**

Michael M. Mincarone¹ and John E. McCosker²

¹ *Museu Oceanográfico do Vale do Itajaí, Univali, CP 360, Itajaí, SC, Brazil, 88302-202. Email: mincarone@bc.univali.br;* ² *California Academy of Sciences, Golden Gate Park, San Francisco, California 94118-4599. Email: jmcosker@calacademy.org.*

We describe *Eptatretus lakeside* sp. nov. from a deepwater (762 m) specimen trapped off Fernandina Island, Galápagos Islands. The new species differs from all known *Eptatretus* in having: five pairs of gill pouches; 3-cusp multicusps in anterior and posterior rows; 6 unicusps in each anterior and posterior row; 36 total cusps; 19 tail pores; 88 total pores; palatine tooth triangular; and body coloration pinkish-orange. A key to the species of Galápagos hagfishes is provided.

The myxinoid fauna of the Galápagos Archipelago was unknown until 1995 when the California Academy of Sciences (CAS) / Harbor Branch Oceanographic Institute (HBOI) expedition made numerous deepwater collections using the submersible *Johnson Sea-Link*. During that cruise, three species of *Eptatretus*, *E. grouseri*, *E. mccoskeri*, and *E. wisneri* were trapped and all were described as new (McMillan 1999). A subsequent expedition in 1998 involving CAS, HBOI, and the National Museum of Natural History (USNM), again using the submersible *Johnson Sea-Link*, captured additional specimens of hagfishes, including a single remarkable specimen of *Eptatretus*, which is described herein as new.

Hagfishes are rare in the eastern tropical Pacific but abundant in the temperate and subtemperate eastern Pacific. In fact, the extensive deepwater collections off Central America and the Galápagos made by the U.S. Fish Commission Steamer *Albatross* in 1891 (Garman 1899) resulted in but one hagfish specimen. It was captured over a rocky bottom in 730 fathoms (1335 m) in the southern end of the Gulf of Panama and described as *Myxine circifrons* Garman, 1899. In contrast to the *Albatross*, the successful capture of hagfishes by the recent expeditions can be explained by the difficulty that the *Albatross* expedition had in trawling over unusually rocky terrain, and by the undeniable benefits provided by manned submersibles in exploring and collecting in complex deepwater habitats.

Currently, there are 30 recognized species of *Eptatretus*, 12 of which are known from the eastern Pacific (McMillan and Wisner 1984; Wisner and McMillan 1988, 1990; McMillan 1999). Undoubtedly more species remain to be discovered.

MATERIALS AND METHODS

The type of the new species as well as the holotypes of all other hagfishes from the Galápagos Islands are deposited in the Department of Ichthyology of the California Academy of Sciences (CAS), San Francisco. Other type specimens examined are deposited in the Scripps Institution of Oceanography (SIO), La Jolla, and National Museum of Natural History (USNM), Washington, D.C.

Methods of measuring and counting follow those of Fernholm and Hubbs (1981) and McMillan and Wisner (1984). The names of anatomical structures follow Wisner and McMillan (1995) and Mok (2001). Length of the specimens (in mm) is given as total length (TL), the distance from the front of the rostrum to the end of the caudal finfold. All other measurements are given in percentage of TL. Counts of gill pouches (GP), gill apertures (GA), and cusps are taken for both sides, whereas slime pore counts are from the left side. Measurements and counts are given in Table 1 and compared with data of all other *Eptatretus* species previously known from the Galápagos Islands. We provide drawings from the anterior and posterior sets of cusps, including the palatine tooth, which are not usually useful characters to identify hagfish species, but in this case they aid in distinguishing species. We provide a key to the *Eptatretus* species from the Galápagos Islands, which was modified from McMillan (1999).

***Eptatretus lakeside* Mincarone and McCosker, sp. nov.**

(Figs. 1, 3; Table 1)

MATERIAL EXAMINED.— Holotype: CAS 201880 (field number JM-155), an immature female, 275 mm TL, from off Cabo Douglas, NW Fernandina Island, Galápagos Islands, 00°17'30"S, 91°39'36"W, 762 m depth, collected on 17 July 1998 by David Pawson and Godfrey Merlen, using a baited metallic minnow trap, deployed while aboard the submersible R/V *Johnson Sea-Link* (JSL Dive 3101).

DIAGNOSIS.— *Eptatretus lakeside* can be distinguished from its congeners by a combination of the followings characters: five pairs of gill pouches; 3-cusp multicusps in anterior and posterior rows; 6 unicusps in each anterior and posterior rows; 36 total cusps; 19 tail pores; 88 total pores; palatine tooth triangular; and body coloration pinkish-orange.

DESCRIPTION OF THE HOLOTYPE.— Body subcylindrical and slender, slightly deeper than wide at prebranchial, branchial, and trunk regions and strongly compressed at tail. Rostrum bluntly rounded; nasopharyngeal duct cylindrical, tube-like, slightly projecting. One pair of conspicuous nasal-sinus papillae on the inner dorsal surface of the nasal sinus. Three pairs of barbels on the head, the first two pairs about equal in size and adjacent to the nasopharyngeal duct; the third pair is immediately adjacent to the oral cavity. Ventral finfold (VFF) conspicuous, 2 mm high, beginning 25 mm behind the last gill aperture and extending backward to the cloaca. Caudal finfold quite thin and rounded, extending around tail to dorsal surface, ending about over cloaca.

Total length 275 mm; prebranchial length 68 mm; branchial length 17 mm; trunk length 145 mm; tail length 50 mm; body width at prebranchial region 14 mm; body depth at mid-trunk including VFF 20 mm; body depth excluding VFF 18 mm; body depth over cloaca 15 mm; tail depth 17 mm. Three-cusp multicusps in anterior and posterior rows of cusps; 6 unicusps in each anterior and posterior row; total cusps 36. Cusps long, slender, and pointed; palatine tooth triangular (Fig. 3). A segmentally arranged row of slime pores on each side, extending from beyond head to behind cloaca. Prebranchial pores 15; branchial pores 4; trunk pores 50; tail pores 19; total pores 88. Four branchial pores are intercalated with five gill apertures on both sides. No slime pore associated with the pharyngocutaneous duct. Five pairs of gill pouches corresponding to five pairs of gill apertures. Last branchial duct confluent with the pharyngocutaneous duct on the left side. First pair of gill pouches lies posterior to end of dental muscle; ventral aorta branches at the second gill pouch.

Body color in alcohol pinkish; barbels and face the same color as body; eyespots present but inconspicuous; ventral finfold pale; caudal finfold with a narrow pale margin. In life, the specimen was pinkish-orange.

DISTRIBUTION.— Known only from the Galápagos Islands.



FIGURE 1. Dorsal view of preserved holotype of *Eptatretus lakeside* (CAS 201880; 275 mm TL).

ETYMOLOGY.— Named *lakeside*, a noun in apposition. We take great pleasure in honoring the Lakeside Foundation of California, which has generously supported the work of the senior author and many other foreign scholars.

Key to Galápagos Species of *Eptatretus*

- 1a. Five or six gill pouches and apertures on each side. 2
- 1b. Eight gill pouches and apertures on each side. 3
- 2a. Body coloration pinkish-orange; 3/3 multicusp pattern; 36 total cusps; 88 total pores
 *Eptatretus lakeside*, new species
- 2b. Body coloration dark brown; 3/2 multicusp pattern; 44–48 total cusps; 71–79 total pores
 *Eptatretus grouseri* McMillan, 1999
- 3a. Prebranchial length 24–26 % of TL; 3/3 multicusp pattern; 48–51 total cusps; 14–15 pre-
 branchial pores *Eptatretus mccoskeri* McMillan, 1999
- 3b. Prebranchial length 19–23 % of TL; 3/2 multicusp pattern; 44 total cusps; 9 prebranchial pores
 *Eptatretus wisneri* McMillan, 1999

COMPARISON.— Three five-gilled species of *Eptatretus* were previously known: *E. grouseri* McMillan, 1999 from the Galápagos Islands, *E. profundus* (Barnard, 1923) from South Africa, and *E. eos* Fernholm, 1991 from the Tasman Sea. All have a 3/2 multicusp pattern, whereas *E. lakeside* has 3/3. *Eptatretus lakeside* also differs from *E. grouseri* in the following characters, respectively:



FIGURE 2. Left lateral view of preserved *Eptatretus grouseri* (CAS 201882; 420 mm TL).

number of unicusps on each row (6 vs. 8–10); total cusps (36 vs. 44–48); tail pores (88 vs. 71–79); shape of palatine tooth (triangular and depressed vs. conic [Fig. 3]); and its body coloration (pinkish-orange [Fig. 1] vs. dark brown [Fig. 2]). Also, the teeth of *E. lakeside* are more slender and more elongate than those of *E. grouseri* (Fig. 3). *Eptatretus lakeside* differs from *E. profundus* in the following characters, respectively (based on the redescription of the holotype of *E. profundus*

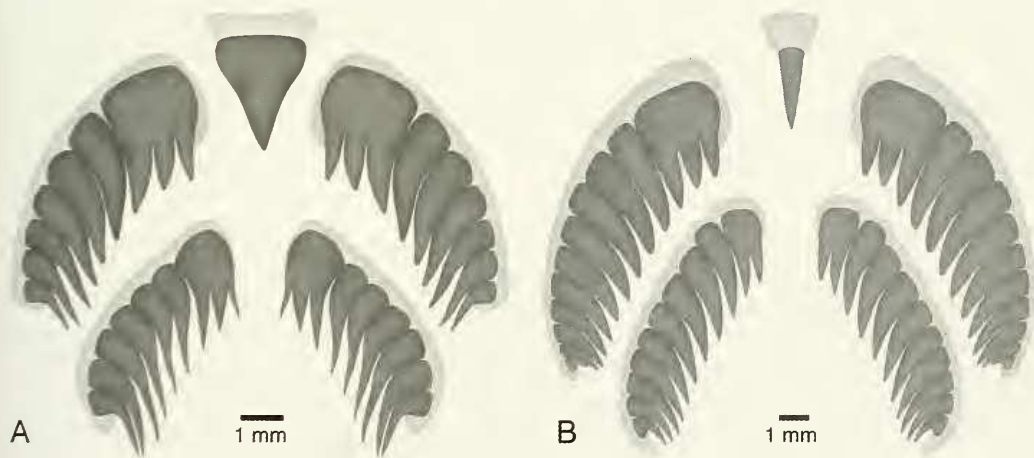


FIGURE 3. Dentition of (A) *Eptatretus lakeside* (CAS 201880, 275 mm TL), and (B) *Eptatretus grouseri* (CAS 201882, 420 mm TL).

TABLE 1. Measurements and counts of *Eptatretus* from the Galápagos Islands.

	<i>E. lakeside</i> Holotype	<i>E. grouseri</i> Holotype	Non-types (2)	<i>E. mccoskeri</i> Holotype	<i>E. wisneri</i> Holotype
Total length TL (mm)	275	370	315–420	310	355
Measurements in % of TL					
Prebranchial length	4.7	20.3	21.0–22.2	25.8	18.9
Branchial length	6.2	8.1	6.3–6.5	10.0	12.1
Trunk length	50.9	57.0	54.0–55.7	48.4	51.3
Tail length	18.2	14.6	16.9–17.5	15.8	17.7
Body width	5.0	5.9	5.4–6.3	7.3	6.5
Body depth					
Inc. ventral finfold	7.2	6.8	7.9–9.0	8.2	8.0
Exc. ventral finfold	6.4	6.8	7.9–8.8	8.2	7.7
Over cloaca	5.4	5.7	6.4–6.5	7.3	6.5
Tail	6.0	6.8	7.6–7.9	8.9	8.3
Counts					
Cusps					
Multicusps	3/3	3/2	3/2	3/3	3/2
Anterior unicusps*	6+6	9+9	9–10	10+10	9+9
Posterior unicusps*	6+6	8+8	9–9	9+10	9+9
Total cusps	36	44	46–48	51	46
Slime pores, left side					
Prebranchial	15	12	11–12	13	9
Branchial	4	4	5–5	7	7
Trunk	50	46	42–48	43	43
Tail	19	15	13–14	10	14
Total pores	88	77	71–79	73	73
Gill apertures*	5+5	5+5	5–6	8+8	8+8
Gill pouches*	5+5	5+5	5–6	8+8	8+8

* Left + right count.

by Strahan 1975): number of unicusps on each row (6 vs. 8); tail pores (19 vs. 15); and its body coloration (pinkish-orange vs. dark brown). Despite the multicusps condition, *E. eos* shares some characters with *E. lakeside*: both have a pinkish body coloration; a long tail (about 18% of TL); an elongated tube-like nostril (longer in *E. eos*); and the same number of unicusps (six). However, *E. lakeside* differs from *E. eos* in the number of prebranchial pores (15 vs. 26), trunk pores (50 vs. 75–77), tail pores (19 vs. 26–27), and total pores (88 vs. 128–130) (based on the original description of the holotype of *E. eos* by Fernholm 1991). The other two *Eptatretus* species from the Galápagos Islands, *E. mccoskeri* and *E. wisneri*, can be easily separated from *E. lakeside* by their having eight pairs of gill pouches and a brownish-black body coloration. The triangular shape of

the palatine tooth is probably an autapomorphy of *E. lakeside* (Fig. 3A). *Nemamyxine kreffii* McMillan & Wisner, 1982, is the only other hagfish that has a similar palatine tooth, but its tooth is more depressed and has a rounded point (Mincarone 2001). In most hagfish species the palatine tooth has a conical shape like a bird's claw (Fig. 3B).

The Galápagos species of *Eptatretus*, albeit based on a very limited sample size, appear to be stratified by depth. The only known *E. mccoskeri* were trapped at 215 m on a seamount SE of San Cristobal Island on the eastern edge of the archipelago. The other species were captured off Fernandina Island (F), along the western edge of the archipelago, and from Seymour (S) Island (= James) in the center of the archipelago. They were trapped at the following depths: *E. wisneri*, 512–563 m (F); *E. grouseri*, 648–722 m (F and S); and *E. lakeside*, 762 m (F).

REMARKS.—The location of capture, Cabo Douglas, is located along the NW corner of Fernandina Island and drops steeply into deep water (more than 1000 m depth at a distance less than 2 km from shore). The specimen was collected using a galvanized metal minnow trap baited with fish flesh and set from the submersible at 0845 and retrieved approximately one hour later. The bottom was nearly flat with a slight downward slope ($<10^\circ$) and covered with fine gray sediment and occasional lava boulders (~0.5 m in diameter) in the vicinity of other large lava reefs. The temperature at depth was 8°C and there was a current of ~0.3 knot. The habitat is further described by Iwamoto and McCosker (2001) who described a new macrourid, *Coryphaenoides gypsochilus*, from that site. Also observed at and near that locality were several pelagic holothurians (*Pelagothuria nanatrix* Ludwig), hagfishes (*Eptatretus grouseri* McMillan and *E. wisneri* McMillan), catsharks (*Apristurus* spp.), combtooth dogfish (*Centroscyllium nigrum* Garman), chimaeras (*Hydrolagus* spp.), witch-eels (*Facciolella equatorialis* (Gilbert)), viperfish (*Chauliodus sloani* Bloch and Schneider), grenadier (*Nezumia loricata loricata* (Garman)), cardinalfish (*Epigonus merleni* McCosker and Long), batfishes (*Dibranchius erinaceus* (Garman)), atelepoidids (*Guentherus ativelis* (Osório)), bythitids (*Diplacanthopoma jordani* (Garman)), and an undescribed scorpionfish (*Phenacoscorpius* sp.).

COMPARATIVE MATERIAL.—*Eptatretus grouseri*: CAS 86428, holotype, 370 mm TL, Punta Espinosa, Fernandina Island, Galápagos Islands, $00^\circ14'36''\text{S}$, $91^\circ26'36''\text{W}$, 722 m; SIO 97–77, paratype, 138 mm TL, taken with holotype; CAS 201882, 2 specimens, 315–420 mm TL, Seymour Island, Galápagos Islands, $00^\circ21'42''\text{S}$, $90^\circ15'00''\text{W}$, 648 m, 25 July 1998, *Johnson Sea-Link* (JSL Dive 3113). *Eptatretus mccoskeri*: CAS 86431, holotype, 310 mm TL, San Cristobal Island, Galápagos Islands, $01^\circ06'19''\text{S}$, $89^\circ06'56''\text{W}$, 215 m; SIO 97–75, paratype, 290 mm TL, taken with holotype; USNM 344905, paratype, 284 mm TL, taken with holotype. *Eptatretus wisneri*: CAS 86429, holotype, 355 mm TL, Cabo Hammond, Fernandina Island, Galápagos Islands, $00^\circ27'56''\text{S}$, $91^\circ37'33''\text{W}$, 563 m; SIO 97–76, paratype, 316 mm TL, Galápagos Islands, $00^\circ17'30''\text{S}$, $91^\circ38'54''\text{W}$, 512 m.

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